NOTICE

All drawings located at the end of the document.

Building 771 Phase 1 Under Building Contamination Characterization Sampling Report

September 2001

REVIEWED FOR CLASSIFICATION/UCNI
By B.M. Hoffman BMH
Date 9-27-01 NA

BUILDING 771 PHASE 1

UNDER BUILDING CONTAMINATION

CHARACTERIZATION SAMPLING REPORT

Rocky Flats Environmental Technology Site

September 27, 2001

2

TABLE OF CONTENTS

Page

LIST OF APPENDICES

3

ACRONYM LIST

AL	Action Level
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CRDL	Contract Required Detection Limit
D&D	Deactivation and Decommissioning
DER	Duplicate Error Ratio
DL	Detection Limit
DOE	Department of Energy
DQA	Data Quality Assessment
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
EMC	Elevated Measurement Comparison
EPA	Environmental Protection Agency
HRR	Historical Release Report
IASAP	Industrial Area Sampling and Analysis Plan
K-H	Kaiser-Hill, L.L.C.
LCS	Lab Control Samples
MD	Matrix Duplicates
MDA	Minimum Detectable Activity
mg/kg	milligrams per kilogram
MS/MSD	Matrix Spikes/Matrix Spike Duplicates
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PB	Preparation Blank
PCBs	Polychlorinated biphenyls
pCi/g	picocuries per gram
pCi/l	picocuries per liter
PCOCs	Potential Contaminants of Concern
QC	Quality Control
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RPD	Relative Percent Difference
SNM	Special Nuclear Material
SOR	Sum of Ratios
TPH	Total Petroleum Hydrocarbons
TPU	Total Propagated Uncertainty
UBC	Under Building Contamination
ug/kg	micrograms per kilogram
VOCs	Volatile Organic Compounds
V&V	Verification and Validation

EXECUTIVE SUMMARY

A preliminary (Phase 1) characterization of Building 771 under building contamination (UBC) was conducted by acquiring approximately 32 subsurface soil samples at 16 locations. The numbers and types of samples, coupled with their specific locations, were collected to determine if contamination existed that would warrant removal of the building's foundation footing for final D&D/site closure, or whether the foundation footing may be left in place.

Analytical results indicate no chemicals or radionuclides in excess of RFCA Tier I action levels in subsurface soil. Arsenic was detected in soil at three locations in excess of both Tier II and background levels. Groundwater was encountered and sampled at four of the 16 sample locations. No analytes exceed Tier I ALs in groundwater. Nitrate and a variety of radionuclides, metals, and VOCs exceed Tier II action levels in groundwater at the four locations. These preliminary results do not suggest either a definitive point source of contamination or a potential source location. Based on these preliminary data, there does not appear to be contamination within the 771 UBC that would warrant removal of the concrete footing; however, final decisions are reserved until the entire 771 UBC characterization is complete.

1.0 INTRODUCTION

This report summarizes the analytical results of the preliminary (Phase 1) characterization of potential under building contamination (UBC) beneath Building 771, located at the Rocky Flats Environmental Technology Site (RFETS). The Phase 1 UBC characterization consisted of sampling near the inside perimeter of Building 771 to evaluate whether soil beneath the building foundation footing is contaminated and requires removal. This preliminary sampling was conducted to assist the Building 771 Deactivation and Decommissioning (D&D) Project in developing a demolition strategy. The sampling activities were conducted in accordance with *Addendum 1 to the Industrial Area Sampling and Analysis Plan* for RFETS (DOE 2001a).

The Building 771 Phase 1 characterization sampling was completed in June 2001. Additional (Phase 2) characterization sampling will be conducted when building D&D commences to address the remainder of the potential Building 771 UBC. Phase 2 characterization activities are planned for completion in 2003. Results of the Phase 2 investigation will be reported following completion of the characterization and remediation of Building 771 UBC, Building 774 UBC and all associated Individual Hazardous Substance Sites and Potential Areas of Concern in the 700-4 Group.

2.0 BACKGROUND

Building 771 is located in the north-central portion of the RFETS Industrial Area (Figure 1, Appendix 1). Beginning in 1953, operations in Building 771 included plutonium foundry and machining processes; coating inspection, radiography, parts and shipping; residue and metal recovery for metal recycle; chemistry and metallurgy research and development; and laboratory analysis for the building operations.

The potential for UBC at Building 771 is based on documented releases described in the RFETS Historical Release Report (HRR) (DOE 1992), the HRR Annual Update (DOE 2000), and the Facility History for Building 771 at the Rocky Flats Plant (Chew 1992). In addition to building process knowledge, these data sources were used to select biased sample locations inside the building and identify potential contaminants for sample analysis in support of the Phase 1 UBC characterization.

3.0 CHARACTERIZATION SAMPLING

The Phase 1 characterization sample locations were selected in areas of known or suspected releases around the inside perimeter structural supports and along expansion joints and footings within the interior of Building 771. A total of 16 sample points were identified (Figure 2, Appendix 1). Samples were collected beneath the foundation slab from 13 locations along the inside perimeter of the building and 3 locations within the building interior. Table 3.1 below summarizes the sampling specifications and rationale for the biased sampling locations.

3.1 Soil Sampling

Samples were collected from beneath the foundation slab through a core hole drilled through the concrete at each sampling location (see photographs in Appendix 4). The concrete coring was conducted using a HILTI Model DD-160 drill with a 4-inch-diameter (17-inch-long) heavy-duty, diamond concrete coring bit. Prior to coring through the slab, paint was removed from the concrete surface to minimize the potential for cross-contamination from the paint to the soil. The concrete cores were collected and provided to the Building 771 Closure Project.

6

Following removal of the concrete cores, the underlying gravel was removed by hand to expose the soil substrate before sampling. Discrete soil samples were collected from the 0-to 2-foot and the 2- to 4-foot depth intervals beneath the foundation using a hand auger. Due to an obstruction encountered at a depth of 3 feet at sample Location 4, samples were collected from 0 to 2 feet and from 2 to 3 feet beneath the foundation. Also, due to the limited access through the 24.5-inch-thick concrete slab at Location 6, samples were collected from the 0- to 22-inch depth interval and from the 22- to 27-inch interval at this location. A total of 32 discrete soil samples were collected.

For each sample interval, grab samples were taken at the top of the interval and containerized for volatile organic compound (VOC) analysis. The remaining soil from the sample interval was composited and transferred to appropriate sample containers for additional analyses (see Section 4.0). In addition to the 32 soil samples, two duplicate samples and two equipment rinsate samples were obtained.

Table 3.1 Sampling Specifications and Rationale

Location	Sampling Purpose	Sampling Technique	Sample Depth Intervals (Each Location)*	Comments
1	Inside Perimeter Characterization	Manual Soil Auger	1) 0 to 2.0 ft. 2) 2.0 to 4.0 ft.	Room 181A; Fire/Spill related releases
2				Corridor E; Area flooded during Building 776 fire and water line break, located near building sump
3				Room 182; Fire/Spill related releases
4				Room 182; Fire/Spill related releases
5				Room 182A; Flood area from Building 776 fire
6				Building 776/771 tunnel airlock; Conduit for Building 776 fire and water line break
7				Room 184; Former storage vault
8				Room 187; Former storage vault
9				Room 188; Former SNM storage vault, early releases
10	Interior Building Characterization			Room 165; Wall and foundation contaminated by 1957 fire
11				Room 149; Void space beneath building slab
12				Room 114; West side of infinity room, multiple spills of plutonium and plutonium/beryllium
13	Inside Perimeter Characterization			Room 146B; Multiple nitric acid spills
14				Room 146C; Multiple nitric acid spills
15				Corridor H; Near Plenum Deluge Catch Tank
16				Corridor G; East of Room 141/Elevator shaft

* With the exception of locations 4 and 6 as noted in Section 3.1

3.2 Groundwater Sampling

Groundwater was encountered at five sample locations (Locations 3, 4, 6, 14 and 16). Water samples were collected at four of the five locations. There was insufficient groundwater at Location 4 to collect a sample.

Prior to sampling, the depth to groundwater was measured from beneath the bottom of the foundation slab. Collected water was field-measured for pH and electrical conductance. Results of these measurements are presented below in Table 3.2.

Table 3.2 Groundwater Measurements

Sample Location	Groundwater Depth (inches)	pH	Electrical Conductance (microsiemens/centimeter)
3	28	7.77	707
6	30	7.84	1,090
14	44	6.0	730
16	44	7.96	849

The observed conductance values are within the normal range for groundwater at RFETS. The pH measured in groundwater from Locations 3, 6 and 16 are also considered normal for groundwater at RFETS. The pH value measured in water from Location 14 is considered mildly acidic.

3.2.1 Physical Conditions

The concrete foundation thickness ranged from 6.5 and 9.25 inches at the 16 sample points located in the building rooms and corridors (Figure 2, Appendix 1). At Location 6, inside the Building 776/771 tunnel airlock, the concrete thickness was measured at 24.5 inches. The layer of gravel underlying the concrete slab ranged from 4 to 12 inches. The gravel ranged in size from ¼ inch to greater than 2 inches. In general, the sampled soils were dry to moist fill material consisting mainly of cohesive weathered claystone.

During the core drilling and sampling activities, the concrete cores and recovered soil were surveyed for radioactive contamination. No radiological contamination was detected on the concrete or in soil removed from beneath the foundation at any of the 16 sample locations. In addition, for health and safety purposes, the core holes were monitored for VOCs with a photoionization detector. No VOCs were detected above 1 part per million at any of the 16 sample locations. Once sampling was completed, the core hole at each location was plugged and sealed with grout.

Concrete obstructions were encountered while sampling at Locations 1, 12 and 13 (Figure 2) at approximately 12 inches beneath the foundation slab. At these three locations, it was necessary to use the HILTI drill to penetrate the obstruction. A 2-inch-thick concrete core was recovered from the drill coring bit at all three locations, indicating that concrete structures underlie the foundation slab in these areas. The origin of this concrete is unknown.

4.0 SAMPLING DATA SUMMARY

The soil samples were analyzed for isotopics by alpha spectroscopy, VOCs, metals, semi-VOCs, polychlorinated biphenyls (PCBs), cyanide, total petroleum hydrocarbons (TPH), and nitrate. Groundwater samples were analyzed for actinides, VOCs, metals, nitrates as nitrogen, and inorganics. Table 4.1 below summarizes the analyses performed and analytical methods used for soil and groundwater samples. Laboratory data records are maintained in the Project File. Electronic laboratory data packages in PDF format will be managed by the K-H Analytical Services Division, according to Environmental Data Management Procedure PRO-1058-ASD-005.

Table 4.1 Soil and Groundwater Analyses and Analytical Methods

Media Analyzed	Analysis Type	Analytical Method
Soil, Groundwater	Isotopics ($Pu^{239/240}$, Am^{241}, $U^{233/234}$, U^{235}, U^{238})	Alpha Spectroscopy
Soil, Groundwater	Metals	SW-846 Method 6010A, 6010B
Soil	Mercury	SW-847OA
Soil, Groundwater	VOCs	SW-846 Method 8260B
Soil	Semi-VOCs	SW-846 Method 8270C
Soil, Groundwater	PCBs (groundwater sample from Location 6 only)	SW-846 Method 8062
Soil	TPH	SW3450B/3550A, 8015
Soil	Cyanide	SW-846 Method 9010B or 9012A
Soil, Groundwater	Inorganic Compounds	SW 846 Method 9056

4.1 Soil Sampling Results

Summary statistics of soil sampling results are presented in Table 4.2 (Appendix 2). None of the samples exceeded Rocky Flats Cleanup Agreement (RFCA) Tier I Action Levels (ALs) for subsurface soil. Arsenic was detected above background and the Tier II AL for subsurface soil. Soils with contaminant concentrations exceeding the RFCA Tier I ALs require remedial action. If the concentrations are between the Tier I and Tier II ALs, further evaluation and/or management action is required. If concentrations are less than the Tier II ALs, no remedial action (or further remedial action) is required. A summary of the analytes detected in soil samples above Tier II ALs is presented in Table 4.3 (Appendix 2).

Many organic analytes such as PCBs, halogenated aromatics, halogenated phenols, polyaromatic hydrocarbons, phthalate esters, and chlorinated solvents were detected, but did not exceed the Tier II ALs (Table 4.2, Appendix 2). Several metals (arsenic, barium, copper, and zinc) were detected above Tier II and Site background concentrations. Only detected organics and metal analytes that exceeded background values were identified as potential contaminants of concern (PCOCs) and were used to calculate the Sum of Ratio (SOR) values presented in Table 4.4 (Appendix 2).

Two iterations of SOR calculations were performed for each depth interval to demonstrate the effect of arsenic values on the SOR values. The first iteration shows Tier II exceedances (as indicated by values > 1.0) at all but a few sampling locations. Whereas the second iteration, which excludes arsenic, shows that all locations are less than the Tier II threshold (i.e., < 1.0). Based on these iterations, arsenic is the only significant contaminant that contributes to the SOR Tier II exceedances.

Arsenic measurements of samples collected from the first and second depth intervals are plotted on Figures 3 and 4 (Appendix 1), respectively. Arsenic measurements at the majority of the sampling locations exceeded the Tier II AL of 2.99 milligrams per kilogram (mg/kg) but not the Site background level of 13.14 mg/kg. As shown in Figure 3 (Appendix 1), arsenic concentrations exceed the background concentration at Locations 2, 3, and 15. Only one arsenic sample (at Location 3) from the second depth

9

interval exceeds the background value of 13.14 mg/kg (Figure 4, Appendix 1). In general, concentrations appear to decrease with depth.

None of the radionuclide analytes exceeded Tier II ALs. The radionuclide SOR calculation, based on the maximum radionuclide PCOC values (Table 4.2), is less than the threshold value of 1.0 for Tier II ALs. The radionuclide PCOCs (amercium-241, plutonium-239/240, uranium-235, and uranium-238) were based on maximum values detected above Site background activities. All uranium-233/234 values were less than the Site background activity and therefore the maximum uranium-233/234 value was not used to calculate the SOR.

4.2 Groundwater Sampling Results

Summary statistics of groundwater sampling results are presented in Table 4.5 (Appendix 2). While no analytes exceed Tier I ALs, several radionuclides, metals, and VOCs exceeded Tier II ALs. The actinides plutonium-239/240, americium- 241, uranium-233/234, and uranium-238 were detected above Tier II ALs at Location 6 (771/776 tunnel airlock) and at Location 16 (East Hallway). Uranium-233/234 and uranium-238 were detected above Tier II ALs at Locations 3 (Room 182) and 14 (Room 146C). VOCs were detected above Tier II ALs at Locations 6 and 16, and one or more metals were detected at Locations 3, 6, 14 and 16. A summary of the analytes detected in groundwater samples above Tier II ALs is presented in Table 4.3 (Appendix 2).

Table 4.6 (Appendix 2) summarizes the number of Tier II exceedances at each location. Tier II exceedances of actinides were detected at all four groundwater sampling locations. The majority of metals exceeding Tier II ALs occurred at Location 16 (East Hallway). The majority of VOCs exceeding Tier II ALs occurred at Location 6. Overall, the highest frequency of actinides and metals exceedances occurred at Location 16. Amongst the four sampling locations, the highest degree of contamination (chemical and radioactive) appears to be present at Locations 6 and 16.

5.0 WASTE DISPOSITION

All waste generated in association with the project was disposed of by the Building 771 Waste Management Group, in accordance with the 771 Waste Generating Instructions applicable for the given waste stream. There were four main types of waste:

1) Dry combustibles, such as dry paper wipes, tape and gloves. These items were disposed of by Building 771 with other dry combustibles generated in 771.

2) Wet combustibles such as wet wipes and wet plastic. These items were disposed of as low-level waste by Building 771 with other wet combustibles generated in 771.

3) Excess gravel and soil. All was disposed of by Building 771 as low-level waste.

4) Water collected from the wet/dry vacuum used for drill bit cooling and excess groundwater. All water (approximately 90 gallons) was sampled and analyzed by Building 771. Results of the analyses allowed for the water to be poured down the process drain within Building 771.

6.0 CONCLUSIONS

Based on the findings of the preliminary (Phase 1) characterization of UBC beneath Building 771, the following conclusions are made.

10

- No analytes were detected above the RFCA Tier I ALs for subsurface soil.
- Only arsenic was detected above the Tier II ALs for subsurface soil. Arsenic concentrations detected in samples collected from the first depth interval exceed the Tier II AL of 2.99 mg/kg at all 16 locations sampled; however, arsenic concentrations are below the Site background level (13.14 mg/kg) at all but three locations (Locations 2, 3, and 15).
- Arsenic is the only significant contaminant that contributes to the SOR Tier II exceedances.
- No analytes were detected above the RFCA Tier I ALs for groundwater at Locations 3, 6, 14, and 16.
- One or more actinides were detected in groundwater above Tier II ALs at sample Locations 3, 6, 14, and 16. One or more metals were detected above Tier II ALs at all four sample locations. VOCs were detected above Tier II ALs at Location 6 (776/771 tunnel airlock) and Location 16 (East Hallway) (see Table 4.5 in Appendix 2).
- Locations and depths of contaminants do not suggest either a definitive point source of contamination or a potential source location. Rationale for this preliminary conclusion are as follows:
    - arsenic exceedances in soil are not consistent in depth between the first and second depth intervals,
    - the Tier II exceedances observed in groundwater are from locations where surrounding soils are below action levels, and
    - there is no apparent correlation between groundwater contaminant location, type, or magnitude with any soil contaminant location, type, or magnitude.

A complete characterization to determine the nature and extent of Building 771 UBC is planned for completion in 2003 at the time of building D&D.

7.0 REFERENCES

Chew and Associates, 1992, *Facility History for Building 771 at the Rocky Flats Plant*, compiled for EM-30 by M.H. Chew and Associates.

DOE, 2001a, Addendum 1 to the Industrial Area Sampling and Analysis Plan – Preliminary Building 771 Under Building Contamination, Rocky Flats Environmental Technology Site, Golden, Colorado, March.

DOE, 2001b, *Industrial Area Sampling and Analysis Plan*, Rocky Flats Environmental Technology Site, Golden, CO.

DOE, 2000, *Historical Release Report Annual Update,* DOE Rocky Flats Environmental Technology Site, Golden, Colorado, September.

DOE, 1996, Rocky Flats Cleanup Agreement, Final, July.

DOE, 1995, Geochemical Characterization of Background Surface Soils: Background Soils Characterization Program, May.

DOE, 1993, Background Geochemical Characterization Report, September.

DOE, 1992, *Historical Release Report for the Rocky Flats Plant,* DOE Rocky Flats Environmental Technology Site, Golden, Colorado, June.

EPA, 2000, Guidance on the Data Quality Objective Process (QA/G4), September.

EPA, 1994, US EPA Contract Laboratory Program, National Functional Guidelines for Organic Data Review, EPA 540/R-94/012.

K-H, 1997, *Kaiser-Hill Team Quality Assurance Program, PADC-1996-00051,* September.

APPENDIX 1

FIGURES

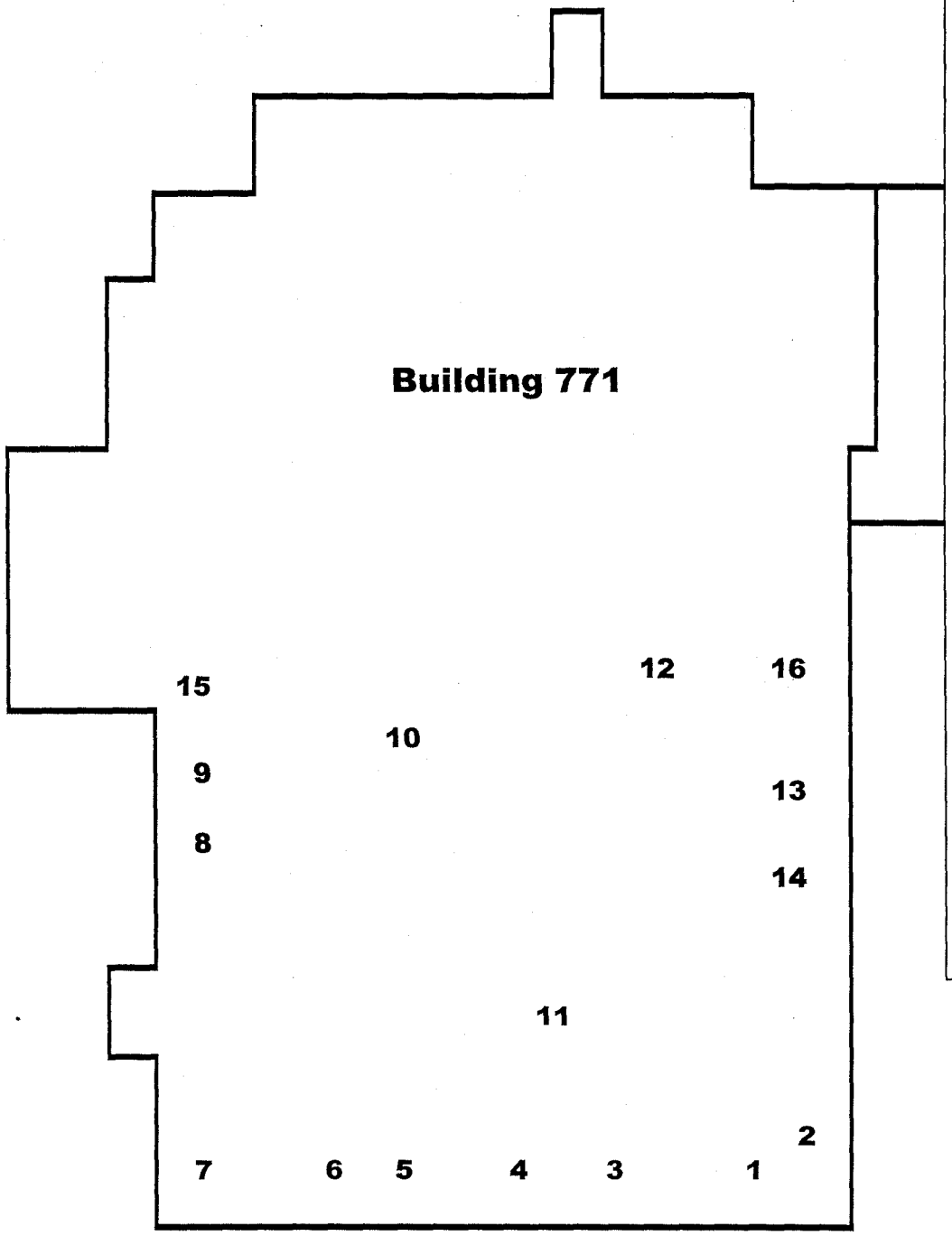


Figure 2.
Building 771 UBC Phase 1
Sampling Locations

1 – ER Biased location: Fire/spill related releases

2 – ER Biased location: Area flooded during 776 fire and water line break

3 – ER Biased location: Fire/spill related releases

4 - ER Biased location: Fire/spill related releases

5 – ER Biased optional location: Flood area from 776 fire and water line break

6 – ER Biased location: Conduit for 776 fire and water line break; hallway leading to 776 tunnel

7 – ER Biased location: Former storage vault; groundwater flow path

8 – ER Biased optional location: former storage vault

9 – ER Biased location: former SNM storage vault; early releases

10 – D&D Internal location: Rm 180K wall and foundation contaminated by 1957 fire

11 – D&D Internal location: Void space investigation

12 – D&D Internal location: Multiple spills of Pu and Pu/Be

13 – ER Biased location: Multiple HNO3 releases

14 - ER Biased location: Multiple HNO3 releases

15 – ER Biased location: West building perimeter

16 – ER Biased location: Across from elevator shaft and Infinity Room

North

Not to Scale

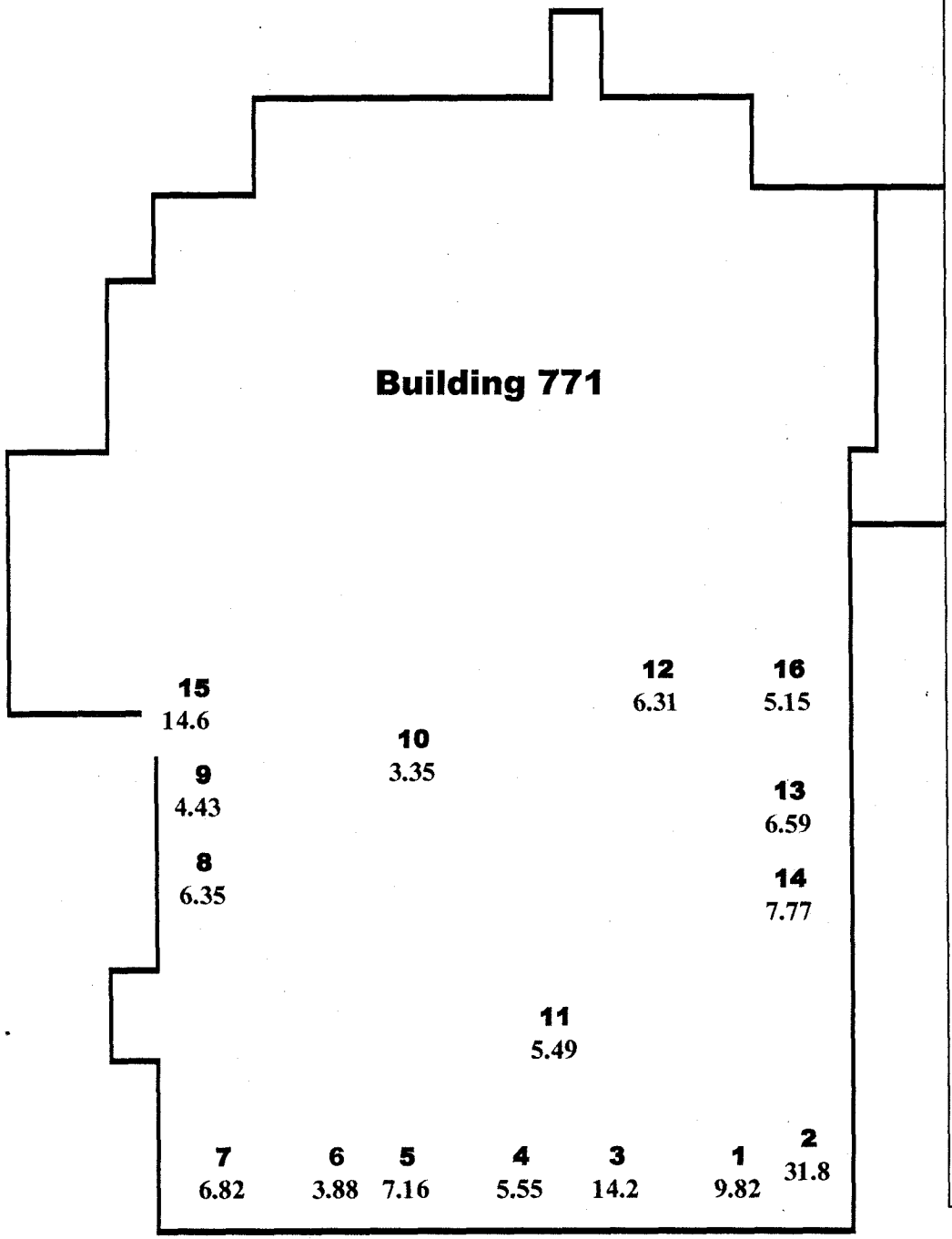


Figure 3.
Building 771 UBC Phase 1
Arsenic Concentrations
1st Depth Interval

1 – ER Biased location: Fire/spill related releases

2 – ER Biased location: Area flooded during 776 fire and water line break

3 – ER Biased location: Fire/spill related releases

4 - ER Biased location: Fire/spill related releases

5 – ER Biased optional location: Flood area from 776 fire and water line break

6 – ER Biased location: Conduit for 776 fire and water line break; hallway leading to 776 tunnel

7 – ER Biased location: Former storage vault; groundwater flow path

8 – ER Biased optional location: former storage vault

9 – ER Biased location: former SNM storage vault; early releases

10 – D&D Internal location: Rm 180K wall and foundation contaminated by 1957 fire

11 – D&D Internal location: Void space investigation

12 – D&D Internal location: Multiple spills of Pu and Pu/Be

13 – ER Biased location: Multiple HNO3 releases

14 - ER Biased location: Multiple HNO3 releases

15 – ER Biased location: West building perimeter

16 – ER Biased location: Across from elevator shaft and Infinity Room

14.6– Concentration detected above Tier II Action Level and background level for As.

Values reported in mg/kg.

North

Not to Scale

16

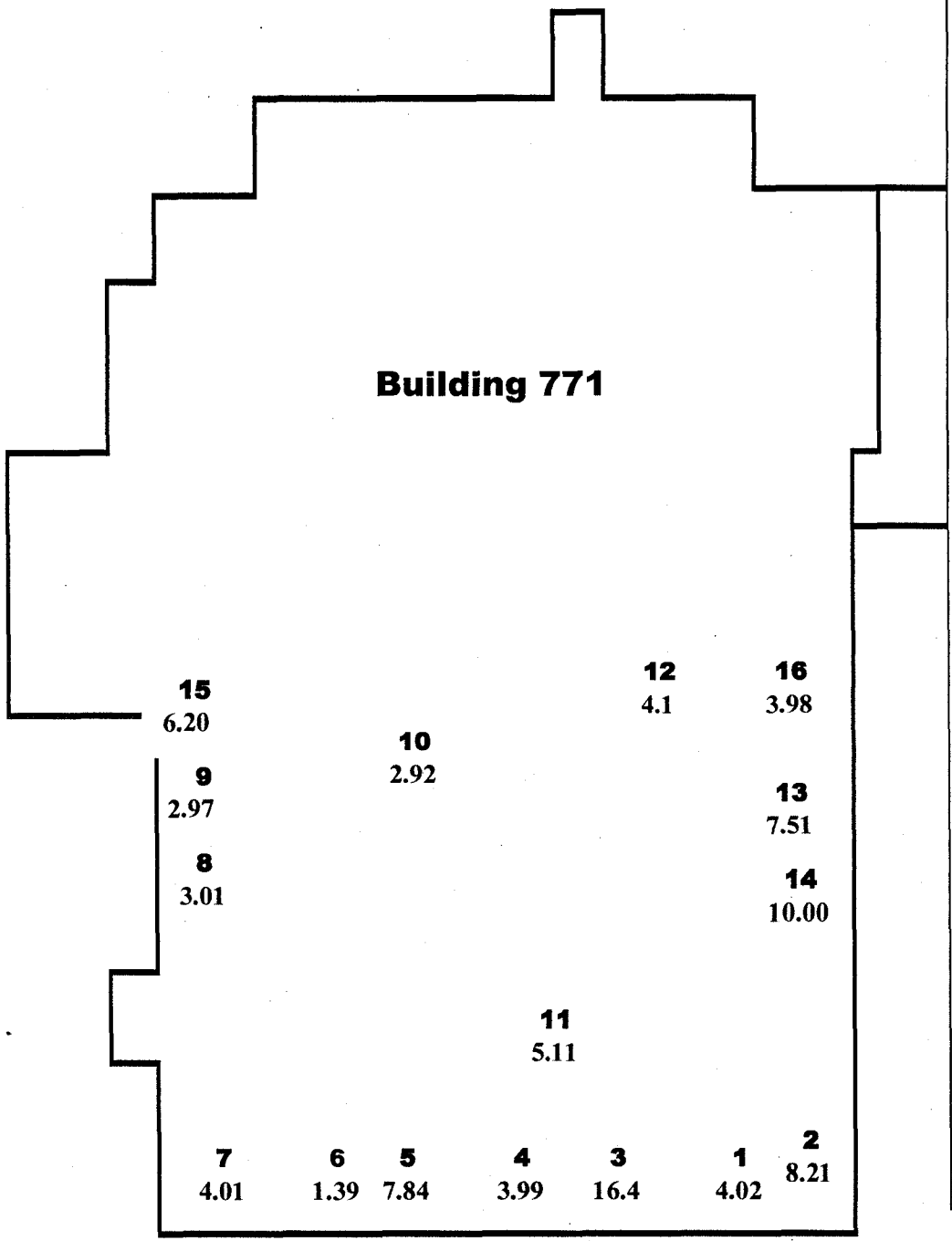


Figure 4.
Building 771 UBC Phase 1
Arsenic Concentrations
2nd Depth Interval

1 – ER Biased location: Fire/spill related releases

2 – ER Biased location: Area flooded during 776 fire and water line break

3 – ER Biased location: Fire/spill related releases

4 - ER Biased location: Fire/spill related releases

5 – ER Biased optional location: Flood area from 776 fire and water line break

6 – ER Biased location: Conduit for 776 fire and water line break; hallway leading to 776 tunnel

7 – ER Biased location: Former storage vault; groundwater flow path

8 – ER Biased optional location: former storage vault

9 – ER Biased location: former SNM storage vault; early releases

10 – D&D Internal location: Rm 180K wall and foundation contaminated by 1957 fire

11 – D&D Internal location: Void space investigation

12 – D&D Internal location: Multiple spills of Pu and Pu/Be

13 – ER Biased location: Multiple HNO3 releases

14 - ER Biased location: Multiple HNO3 releases

15 – ER Biased location: West building perimeter

16 – ER Biased location: Across from elevator shaft and Infinity Room

16.4– Concentration detected above Tier II Action Level and background level for As.

Values reported in mg/kg.

North

Not to Scale

17

APPENDIX 2

TABLES

Table 4.2
Soil Summary Statistics

ANALYTE	MEAN	MIN	MAX	SD	BKGD	TIER I AL	TIER II AL	NO.	NO. DETECTS	Units
Radionuclides										
AM 241	0.42	0	12.8	2.26	0.02	215	38	32	7	pCi/g
PU 239/240	4.98	0	157	27.74	0.02	1429	252	32	13	pCi/g
U 233,234	1.28	0.68	2.1	0.38	2.64	1738	307	32	32	pCi/g
U 235	0.03	0	0.5	0.1	0.12	135	24	32	5	pCi/g
U 238	1.11	0.64	1.9	0.28	1.49	586	103	32	32	pCi/g
Metals										
Aluminum	11142.1	3100	17200	3160.42	35373.17	1000000	1000000	32	32	mg/kg
Antimony	0.4	0	1	0.2	16.97	768	768	32	31	mg/kg
Arsenic	7.22	1.39	31.8	5.68	13.14	299	2.99	32	32	mg/kg
Barium	106.98	30.5	333	66.75	289.38	133000	133000	32	32	mg/kg
Beryllium	0.82	0.27	1	0.17	14.2	104	1.04	32	32	mg/kg
Boron	2.8	0	19.9	3.4				32	31	mg/kg
Cadmium	0.21	0	1.1	0.27	1.7	1920	1920	32	25	mg/kg
Calcium	5826.56	1730	8800	1461.45	39382.27			32	32	mg/kg
Chromium	14.23	3.81	56.4	8.47				32	32	mg/kg
Cobalt	8.4	3.31	27.7	4.59	29.04	115000	115000	32	32	mg/kg
Copper	48.32	4.9	421	88.18	38.21	71100	71100	32	32	mg/kg
Iron	15501.5	4970	34300	5806.38	41046.52	576000	576000	32	32	mg/kg
Lead	15.86	5.61	23.8	5.1	24.97	1000	1000	32	32	mg/kg
Lithium	8.92	4.61	29.3	4.45	34.66	38400	38400	32	32	mg/kg
Magnesium	2664.69	1020	3720	561.67	9315.44			32	32	mg/kg
Manganese	152.1	35.2	441	95.68	901.62	83600	83600	32	32	mg/kg
Mercury	0.06	0.02	0.1	0.03	1.52	576	576	32	32	mg/kg
Molybdenum	0.58	0	1.9	0.47	25.61	9610	9610	32	27	mg/kg
Nickel	15.85	5.77	33.8	6.26	62.21	38400	38400	32	32	mg/kg
Potassium	1290.69	473	2010	349.39	6196.81			32	32	mg/kg
Selenium	0.57	0	2.7	0.59	4.8	9610	9610	32	21	mg/kg
Silica	1489.91	198	5110	1012.75				32	32	mg/kg
Silver	0.2	0	3.3	0.59	24.54	9610	9610	32	13	mg/kg
Sodium	124.98	30.4	274	59.54	1251.24			32	32	mg/kg
Strontium	49.98	14.8	107	21.85	211.38	1000000	1000000	32	32	mg/kg
Thallium	0.09	0	0.8	0.23	1.84			32	4	mg/kg
Tin	0.77	0	3	0.45	286.31	1000000	1000000	32	31	mg/kg
Titanium	100.96	26.1	283	60				32	32	mg/kg
Uranium	1.12	0	5.3	1.73				32	11	mg/kg
Vanadium	24.16	7.06	38	6.96	88.49	13400	13400	32	32	mg/kg
Zinc	63.36	26	195	30.16	139.1	576000	576000	32	32	mg/kg
Inorganic Parameters										
Acid Soluble Sulfides	2.81	0	9	3.02				32	17	mg/kg
Cyanide, Total	0.01	0	0.1	0.03		38400	38400	32	1	mg/kg
Bromide	0	0	0	0				32	0	mg/kg
Chloride	114.46	6.08	283	57.64				20	20	mg/kg
Fluoride	8.16	0	15.7	3.8		115000	115000	20	19	mg/kg
Nitrate	2.23	0	10.2	2.34				20	19	mg/kg
Nitrite	0.07	0	1.2	0.27				20	2	mg/kg
Ortho-phosphate	0	0	0	0				20	0	mg/kg
Sulfate	31.47	9.02	85	23.67				20	20	mg/kg
Diesel Range Organics	1	0	4.5	0.89				30	22	mg/kg
Gasoline Range Organics	3.54	0	65.4	13.84				30	2	mg/kg
PCBs										
Aroclor-1016	0	0	0	0		531000	5310	32	0	µg/kg
Aroclor-1221	0	0	0	0		531000	5310	32	0	µg/kg
Aroclor-1232	0	0	0	0		531000	5310	32	0	µg/kg
Aroclor-1242	0	0	0	0		531000	5310	32	0	µg/kg
Aroclor-1248	0	0	0	0		531000	5310	32	0	µg/kg
Aroclor-1254	3.71	0	27.1	7.59		531000	5310	32	8	µg/kg
Aroclor-1260	0.46	0	6.7	1.55		531000	5310	32	3	µg/kg

Table 4.2
Soil Summary Statistics

ANALYTE	MEAN	MIN	MAX	SD	BKGD	TIER I AL	TIER II AL	NO.	NO. DETECTS	Units
SVOCs										
1,2-Dichlorobenzene	5.7	5.7	5.7			1320000	13200	1	1	µg/kg
1,3-Dichlorobenzene	5.3	5.3	5.3					1	1	µg/kg
2,4,5-Trichlorophenol	0	0	0	0		279000	2790	32	0	µg/kg
2,4,6-Trichlorophenol	0	0	0	0		10700	107	32	0	µg/kg
2,4-Dichlorophenol	0	0	0	0		63500	635	32	0	µg/kg
2,4-Dimethylphenol	0	0	0	0		577000	5770	32	0	µg/kg
2,4-Dinitrophenol	0	0	0	0		5290	52.9	32	0	µg/kg
2,4-Dinitrotoluene	0	0	0	0		50.1	0.501	32	0	µg/kg
2,6-Dinitrotoluene	0	0	0	0		38.8	0.388	32	0	µg/kg
2-Chloronaphthalene	0	0	0	0				32	0	µg/kg
2-Chlorophenol	0.27	0	8.5	1.5		257000	2570	32	1	µg/kg
2-Methyl-4,6-dinitrophenol	0	0	0	0				32	0	µg/kg
2-Methylnaphthalene	2.91	0	65.6	12.11				32	3	µg/kg
2-Nitrophenol	0	0	0	0				32	0	µg/kg
3,3'-Dichlorobenzidine	0	0	0	0		484	4.84	32	0	µg/kg
4-Bromophenylphenylether	0	0	0	0				32	0	µg/kg
4-Chloro-3-methylphenol	0	0	0	0				32	0	µg/kg
4-Chloroaniline	0	0	0	0		43700	437	32	0	µg/kg
4-Chlorophenylphenylether	0	0	0	0				32	0	µg/kg
4-Nitrophenol	0	0	0	0				32	0	µg/kg
Acenaphthene	1.2	0	38.3	6.77		53400000	534000	32	1	µg/kg
Acenaphthylene	0	0	0	0				32	0	µg/kg
Anthracene	1.22	0	39.1	6.91		100000000	11200000	32	1	µg/kg
Benzo(a)anthracene	4.38	0	140	24.75		160000	1600	32	1	µg/kg
Benzo(a)pyrene	0.18	0	5.7	1.01		701000	7010	32	1	µg/kg
Benzo(b)fluoranthene	3.39	0	78.9	14.35		495000	4950	32	3	µg/kg
Benzo(ghi)perylene	0.41	0	13.2	2.33				32	1	µg/kg
Benzo(k)fluoranthene	0.37	0	11.9	2.1		4950000	49500	32	1	µg/kg
Benzoic acid	0	0	0	0		10900000	109000	32	0	µg/kg
Benzyl alcohol	0	0	0	0				32	0	µg/kg
bis(2-Chloroethoxy)methane	0	0	0	0				32	0	µg/kg
bis(2-Chloroethyl) ether	0	0	0	0		9.73	0.0973	32	0	µg/kg
bis(2-Chloroisopropyl)ether	0	0	0	0				32	0	µg/kg
bis(2-Ethylhexyl)phthalate	17.83	0	129	33.12		31100000	3110000	32	12	µg/kg
Butylbenzylphthalate	0.52	0	16.5	2.92		10000000	14400000	32	1	µg/kg
Chrysene	7.68	0	192	34.95		16000000	160000	32	2	µg/kg
Di-n-butylphthalate	0	0	0	0		426000000	4260000	32	0	µg/kg
Di-n-octylphthalate	0.65	0	20.9	3.69		100000000	1E+09	32	1	µg/kg
Dibenzo(a,h)anthracene	0.42	0	13.6	2.4		153000	1530	32	1	µg/kg
Dibenzofuran	0.28	0	8.9	1.57				32	1	µg/kg
Diethylphthalate	3.03	0	37.4	9.73		31000000	310000	32	3	µg/kg
Dimethylphthalate	0	0	0	0				32	0	µg/kg
Diphenylamine	0	0	0	0		78400	784	32	0	µg/kg
Fluoranthene	11.13	0	281	50.75		537000000	5370000	32	3	µg/kg
Fluorene	0.42	0	13.6	2.4		69400000	694000	32	1	µg/kg
Hexachlorobenzene	0	0	0	0		189000	1890	32	0	µg/kg
Hexachlorocyclopentadiene	0	0	0	0		34400000	344000	32	0	µg/kg
Hexachloroethane	0	0	0	0		37700	377	32	0	µg/kg
Indeno(1,2,3-cd)pyrene	0.29	0	9.4	1.66		1400000	14000	32	1	µg/kg
Isophorone	0	0	0	0		20900	209	32	0	µg/kg
m,p-Cresols	0	0	0	0				32	0	µg/kg
m-Nitroaniline	0	0	0	0				32	0	µg/kg
N-Nitrosodipropylamine	0	0	0	0		1.89	0.0189	32	0	µg/kg
Naphthalene	11.7	5.1	18.3	9.33		10100000	101000	2	2	µg/kg
Nitrobenzene	0	0	0	0		5390	53.9	32	0	µg/kg
o-Cresol	0	0	0	0		706000	7060	32	0	µg/kg
o-Nitroaniline	0	0	0	0				32	0	µg/kg
p-Nitroaniline	0	0	0	0				32	0	µg/kg
Pentachlorophenol	0	0	0	0		2110	21.1	32	0	µg/kg
Phenanthrene	7.53	0	241	42.6				32	1	µg/kg
Phenol	0	0	0	0		3750000	37500	32	0	µg/kg
Pyrene	14.71	0	377	68.15		39700000	3970000	32	2	µg/kg
Tributylphosphate	0	0	0	0				32	0	µg/kg

Table 4.2
Soil Summary Statistics

ANALYTE	MEAN	MIN	MAX	SD	BKGD	TIER I AL	TIER II AL	NO.	NO. DETECTS	Units
VOCs										
1,1,1,2-Tetrachloroethane	0	0	0	0				32	0	µg/kg
1,1,1-Trichloroethane	0	0	0	0		94800	948	32	0	µg/kg
1,1,2,2-Tetrachloroethane	0	0	0	0		168	1.68	32	0	µg/kg
1,1,2-Trichloroethane	0	0	0	0		1230	12.3	32	0	µg/kg
1,1-Dichloroethane	0	0	0	0		689000	6890	32	0	µg/kg
1,1-Dichloroethylene	0	0	0	0		14000	140	32	0	µg/kg
1,1-Dichloropropene	0	0	0	0				32	0	µg/kg
1,2,3-Trichlorobenzene	0	0	0	0				32	0	µg/kg
1,2,3-Trichloropropane	0	0	0	0				32	0	µg/kg
1,2,4-Trichlorobenzene	0	0	0	0		433000	4330	32	0	µg/kg
1,2,4-Trimethylbenzene	0	0	0	0				32	0	µg/kg
1,2-Dibromo-3-chloropropane	0	0	0	0				32	0	µg/kg
1,2-Dibromoethane	0	0	0	0				32	0	µg/kg
1,2-Dichlorobenzene	0	0	0	0		1320000	13200	31	0	µg/kg
1,2-Dichloroethane	0	0	0	0		668	6.68	32	0	µg/kg
1,2-Dichloropropane	0	0	0	0		1130	11.3	32	0	µg/kg
1,3,5-Trimethylbenzene	0	0	0	0				32	0	µg/kg
1,3-Dichlorobenzene	0	0	0	0				31	0	µg/kg
1,3-Dichloropropane	0	0	0	0				32	0	µg/kg
1,4-Dichlorobenzene	0.08	0	2.2	0.4		165000	1650	32	2	µg/kg
2,2-Dichloropropane	0	0	0	0				32	0	µg/kg
2-Butanone	0	0	0	0				32	0	µg/kg
2-Chlorotoluene	0	0	0	0				32	0	µg/kg
2-Hexanone	0	0	0	0				32	0	µg/kg
4-Chlorotoluene	0	0	0	0				32	0	µg/kg
4-Isopropyltoluene	0	0	0	0				32	0	µg/kg
4-Methyl-2-pentanone	0	0	0	0				32	0	µg/kg
Acetone	1.16	0	15.5	3.66		27200000	272000	32	7	µg/kg
Benzene	0	0	0	0		1410	14.1	32	0	µg/kg
Bromobenzene	0	0	0	0				32	0	µg/kg
Bromochloromethane	0	0	0	0				32	0	µg/kg
Bromodichloromethane	0	0	0	0		26400	264	32	0	µg/kg
Bromoform	0	0	0	0		37200	372	32	0	µg/kg
Bromomethane	0	0	0	0		5980	59.8	32	0	µg/kg
Carbon disulfide	0	0	0	0		988000	9880	32	0	µg/kg
Carbon tetrachloride	0.09	0	1.6	0.36		3560	35.6	32	2	µg/kg
Chlorobenzene	0	0	0	0		83000	830	32	0	µg/kg
Chloroethane	0	0	0	0				32	0	µg/kg
Chloroform	2.25	0	37.4	8.44		21400	214	32	3	µg/kg
Chloromethane	0	0	0	0				32	0	µg/kg
cis-1,2-Dichloroethylene	0	0	0	0				32	0	µg/kg
cis-1,3-Dichloropropylene	0	0	0	0		120	1.2	32	0	µg/kg
Dibromochloromethane	0	0	0	0				32	0	µg/kg
Dibromomethane	0	0	0	0				32	0	µg/kg
Dichlorodifluoromethane	0	0	0	0				32	0	µg/kg
Ethylbenzene	0	0	0	0		932000	932000	32	0	µg/kg
Hexachlorobutadiene	0	0	0	0		201000	2010	32	0	µg/kg
Isopropylbenzene	0	0	0	0				32	0	µg/kg
Methylene chloride[1]	2.77	0	23.3	4.62		578	5.78	32	26	µg/kg
n-Butylbenzene	0	0	0	0				32	0	µg/kg
n-Propylbenzene	0	0	0	0				32	0	µg/kg
Naphthalene	0.17	0	1.1	0.35		10100000	101000	30	7	µg/kg
sec-Butylbenzene	0	0	0	0				32	0	µg/kg
Styrene	0	0	0	0		274000	2740	32	0	µg/kg
tert-Butylbenzene	0	0	0	0				32	0	µg/kg
Tetrachloroethylene	0.07	0	1.4	0.28		3150	31.5	32	2	µg/kg
Toluene	0	0	0	0		707000	7070	32	0	µg/kg

Table 4.2
Soil Summary Statistics

ANALYTE	MEAN	MIN	MAX	SD	BKGD	TIER I AL	TIER II AL	NO.	NO. DETECTS	Units
trans-1,2-Dichloroethylene	0	0	0	0				32	0	µg/kg
trans-1,3-Dichloropropylene	0	0	0	0		120	1.2	32	0	µg/kg
Trichloroethylene	0	0	0	0		3280	32.8	32	0	µg/kg
Trichlorofluoromethane	0	0	0	0				32	0	µg/kg
Trichlorotrifluoroethane	0	0	0	0				32	0	µg/kg
Vinyl chloride	0	0	0	0		346	3.46	32	0	µg/kg
Xylenes (total)	0	0	0	0		9740000	97400	32	0	µg/kg

[1] Laboratory Contaminant

Shaded result exceeds Tier II Action level for Subsurface Soil

Table 4.3
Summary of Tier II Exceedances
Soil and Groundwater

Location	Analyte	Media	Result	Tier II	Background	Units
2	Arsenic	Subsurface Soil (1st Depth Interval)	31.8	2.99	13.14	mg/kg
3			14.2			
15			14.6			
3		Subsurface Soil (2nd Depth Interval)	16.4			
3	U 233/234	Groundwater	8.85	1.06	NA	pCi/L
	U 238		5.99	0.768		
	Lead		28.1	15		µg/L
6	Am 241	Groundwater	0.205	0.145	NA	pCi/L
	Pu 239/240		0.535	0.151		
	U 233/234		2.08	1.06		
	U 238		1.72	0.768		
	Lead		15.5	15		µg/L
	1,1,2,2 Tetrachloroethene		0.55	0.426		
	Carbon Tetrachloride		371	5		
	Chloroform		367	100		
	Methylene Chloride		5.9	5		
	Tetrachlorethylene		7.6	5		
14	U 233/234	Groundwater	2.08	1.06	NA	pCi/L
	U 238		1.21	0.768		
	Aluminum		52,200	36,500		µg/L
	Lead		34.3	15		
	Nitrate		11.2	10		mg/L
	Selenium		52.2	50		µg/L
16	Am 241	Groundwater	0.309	0.145	NA	pCi/L
	Pu 239/240		0.487	0.151		
	U 233/234		8.39	1.06		
	U 238		7.35	0.768		
	Aluminum		1460000	36500		µg/L
	Arsenic		347	50		
	Barium		8930	2000		
	Beryllium		64.1	4		
	Cadmium		14.7	5		
	Chromium		1110	100		
	Copper		1340	1300		
	Lead		1050	15		
	Lithium		1050	730		
	Manganese		16500	1720		
	Nickel		971	140		
	Vanadium		2000	256		
	Carbon Tetrachloride		17.6	5		

Table 4.4
Soil Sum of Ratio Values

Sampling Summary				1st Iteration		2nd Iteration	
Sample Number	Sampling Location	Room/Area	Sample Depth (inches)	Tier I SOR	Tier II SOR	Tier I SOR	Tier II SOR
01N0194-001	1	181A	0-24	0.03	3.29	<0.01	0.01
01N0194-002			24-48	0.01	1.35	<0.01	<0.01
01N0212-001	2	South Hallway Corridor E	0-24	0.11	10.64	<0.01	<0.01
01N0212-002			24-48	0.03	2.75	<0.01	<0.01
01N0213-001	3	182 East Side	0-24	0.05	4.75	<0.01	<0.01
01N0213-002			24-48	0.06	5.49	<0.01	<0.01
01N0195-001	4	182 West Side	0-24	0.02	1.86	<0.01	<0.01
01N0195-002			24-36	0.02	1.51	<0.01	0.17
01N0208-001	5	182A	0-24	0.02	2.40	<0.01	<0.01
01N0208-002			24-48	0.03	2.62	<0.01	<0.01
01N0232-001	6	771/776 Tunnel	0-22	0.02	1.66	<0.01	0.36
01N0232-002			22-27	0.01	0.53	<0.01	0.07
01N0192-001	7	184	0-24	0.03	2.29	0.01	<0.01
01N0192-002			24-48	0.02	1.34	0.01	<0.01
01N0163-001	8	187	0-24	0.02	2.13	<0.01	<0.01
01N0163-002			24-48	0.01	1.01	<0.01	<0.01
01N0188-001	9	188	0-24	0.02	1.48	<0.01	<0.01
01N0188-002			24-48	0.01	0.99	<0.01	<0.01
01N0186-001	10	165/180K	0-24	0.01	1.13	<0.01	0.01
01N0186-002			24-48	0.01	0.98	<0.01	<0.01
01N0204-001	11	149	0-24	0.02	1.84	<0.01	<0.01
01N0204-002			24-48	0.02	1.71	<0.01	<0.01
01N0202-001	12	114	0-24	0.03	2.12	0.01	0.01
01N0202-002			24-48	0.01	1.37	<0.01	<0.01
01N0190-001	13	146B	0-24	0.02	2.21	<0.01	<0.01
01N0190-002			24-48	0.03	2.53	<0.01	0.02
01N0189-001	14	146C	0-24	0.03	2.61	<0.01	0.01
01N0189-002			24-48	0.04	3.35	<0.01	0.01
01N0203-001	15	West Hallway Corridor H Near 190	0-24	0.05	4.88	<0.01	<0.01
01N0203-002			24-48	0.02	2.07	<0.01	<0.01
01N0219-001	16	East Hallway	0-24	0.02	1.72	<0.01	<0.01
01N0219-002			24-57	0.01	1.33	<0.01	<0.01

1st Iteration Includes all the PCOCs in the SOR calulations.

2nd Iteration excludes arsenic in the SOR calculations.

Table 4.5
Groundwater Summary Statistics

ANALYTE	MEAN	MIN	MAX	SD	TIER I	TIER II	NO.	NO. DETECTS	Units
Radionuclides									
AM241	0.1285	0	0.309	0.15	14.5	0.145	4	2	pCi/L
PU239/240	0.283	0	0.535	0.27	15.1	0.151	4	3	pCi/L
U233/234	5.35	2.08	8.85	3.78	106	1.06	4	4	pCi/L
U235	0.2597	0	0.467	0.24	101	1.01	4	3	pCi/L
U238	4.0675	1.21	7.85	3.06	76.8	0.768	4	4	pCi/L
Metals									
Aluminum	391200	19900	1460000	712657.1	3650000	36500	4	4	µg/L
Antimony	0.6625	0	2.65	1.33	600	6	4	1	µg/L
Arsenic	96.185	0	347	167.84	5000	50	4	3	µg/L
Barium	2497	250	8930	4289.39	200000	2000	4	4	µg/L
Beryllium	16.598	0	64.1	31.68	400	4	4	3	µg/L
Boron	61.7	0	133	54.84			4	3	µg/L
Cadmium	4.078	0	14.7	7.1	500	5	4	3	µg/L
Calcium	295525	93800	835000	360780			4	4	µg/L
Chromium	305.92	17.8	1110	536.33	10000	100	4	4	µg/L
Cobalt	145.37	19.5	464	214.07	219000	2190	4	4	µg/L
Copper	362.9	30.4	1340	651.42	130000	1300	4	4	µg/L
Iron	321250	15200	1190000	579292.9			4	4	µg/L
Lead	281.97	15.5	1050	512.08	1500	15	4	4	µg/L
Lithium	321.67	33	1050	487.3	73000	730	4	4	µg/L
Magnesium	77025	23100	231000	102697.7			4	4	µg/L
Manganese	4501.5	287	16500	8001.66	172000	1720	4	4	µg/L
Mercury	0	0	0	0	200	2	4	0	µg/L
Molybdenum	8.825	3.08	21.4	8.48	18300	183	4	4	µg/L
Nickel	269.37	18.3	971	467.91	14000	140	4	4	µg/L
Potassium	87300	13300	307000	146468.4			4	4	µg/L
Selenium	15.24	0	52.2	24.98	5000	50	4	2	µg/L
Silica	154575	82300	241000	65588.53			4	4	µg/L
Silver	2.4225	0	6.78	3.21	18300	183	4	2	µg/L
Sodium	40575	31600	50800	8163.49			4	4	µg/L
Strontium	1547.5	662	3990	1629.12	2190000	21900	4	4	µg/L
Thallium	0	0	0	0	200	2	4	0	µg/L
Tin	10.365	0	24	10.29	2190000	21900	4	3	µg/L
Titanium	467	356	728	174.95			4	4	µg/L
Uranium	95.8	39	175	57.18			4	4	µg/L
Vanadium	561.3	58.1	2000	959.47	25600	256	4	4	µg/L
Zinc	1340	116	3860	1728.12	1100000	11000	4	4	µg/L
Water Quality Parameters									
Bromide	0.155	0	0.263	0.11			4	3	mg/L
Chloride	104.4	68.9	178	49.84			4	4	mg/L
Fluoride	0.7827	0.372	1.72	0.63	400	4	4	4	mg/L
Nitrate	5.52	1.92	11.2	3.98	1000	10	4	4	mg/L
Nitrite	0	0	0	0	100	1	4	0	mg/L
Ortho-phosphate	0	0	0	0			4	0	mg/L
Sulfate	41.05	30.4	68	18.01			4	4	mg/L
PCBs									
Aroclor-1016	0	0	0		50	0.5	1	0	µg/L
Aroclor-1221	0	0	0		50	0.5	1	0	µg/L
Aroclor-1232	0	0	0		50	0.5	1	0	µg/L
Aroclor-1242	0	0	0		50	0.5	1	0	µg/L
Aroclor-1248	0	0	0		50	0.5	1	0	µg/L
Aroclor-1254	0	0	0		50	0.5	1	0	µg/L
Aroclor-1260	0	0	0		50	0.5	1	0	µg/L

Table 4.5
Groundwater Summary Statistics

ANALYTE	MEAN	MIN	MAX	SD	TIER I	TIER II	NO.	NO. DETECTS	Units
VOCs									
1,1,1,2-Tetrachloroethane	0	0	0	0			4	0	µg/L
1,1,1-Trichloroethane	0	0	0	0	20000	200	4	0	µg/L
1,1,2,2-Tetrachloroethane	0.1375	0	0.55	0.28	42.6	0.426	4	1	µg/L
1,1,2-Trichloroethane	0	0	0	0	500	5	4	0	µg/L
1,1-Dichloroethane	0.325	0	1.3	0.65	365000	3650	4	1	µg/L
1,1-Dichloroethylene	0	0	0	0	700	7	4	0	µg/L
1,1-Dichloropropene	0	0	0	0			4	0	µg/L
1,2,3-Trichlorobenzene	0	0	0	0			4	0	µg/L
1,2,3-Trichloropropane	0	0	0	0			4	0	µg/L
1,2,4-Trichlorobenzene	0	0	0	0	7000	70	4	0	µg/L
1,2,4-Trimethylbenzene	0	0	0	0			4	0	µg/L
1,2-Dibromo-3-chloropropane	0	0	0	0			4	0	µg/L
1,2-Dibromoethane	0	0	0	0			4	0	µg/L
1,2-Dichlorobenzene	0	0	0	0	60000	600	4	0	µg/L
1,2-Dichloroethane	0	0	0	0	500	5	4	0	µg/L
1,2-Dichloropropane	0.2275	0	0.91	0.46	500	5	4	1	µg/L
1,3,5-Trimethylbenzene	0	0	0	0			4	0	µg/L
1,3-Dichlorobenzene	0	0	0	0			4	0	µg/L
1,3-Dichloropropane	0	0	0	0			4	0	µg/L
1,4-Dichlorobenzene	0	0	0	0	7500	75	4	0	µg/L
2,2-Dichloropropane	0	0	0	0			4	0	µg/L
2-Butanone	0	0	0	0	2190000	21900	4	0	µg/L
2-Chlorotoluene	0	0	0	0			4	0	µg/L
2-Hexanone	0	0	0	0			4	0	µg/L
4-Chlorotoluene	0	0	0	0			4	0	µg/L
4-Isopropyltoluene	0	0	0	0			4	0	µg/L
4-Methyl-2-pentanone	0	0	0	0	292000	2920	4	0	µg/L
Acetone	1	0	2.2	1.17	365000	3650	4	2	µg/L
Benzene	0	0	0	0	500	5	4	0	µg/L
Bromobenzene	0	0	0	0			4	0	µg/L
Bromochloromethane	0	0	0	0			4	0	µg/L
Bromodichloromethane	0	0	0	0	10000	100	4	0	µg/L
Bromoform	0	0	0	0	10000	100	4	0	µg/L
Bromomethane	0	0	0	0	5110	51.1	4	0	µg/L
Carbon disulfide	0	0	0	0	365000	3650	4	0	µg/L
Carbon tetrachloride	98.95	2.6	371	181.49	500	5	4	4	µg/L
Chlorobenzene	0	0	0	0	10000	100	4	0	µg/L
Chloroethane	0	0	0	0	2940	29.4	4	0	µg/L
Chloroform	110.57	8	367	171.38	10000	100	4	4	µg/L
Chloromethane	0	0	0	0	655	6.55	4	0	µg/L
cis-1,2-Dichloroethylene	2.375	0	9.5	4.75			4	1	µg/L
cis-1,3-Dichloropropylene	0	0	0	0	47.3	0.473	4	0	µg/L
Dibromochloromethane	0	0	0	0	101	1.01	4	0	µg/L
Dibromomethane	0	0	0	0			4	0	µg/L
Dichlorodifluoromethane	0	0	0	0			4	0	µg/L
Ethylbenzene	0	0	0	0	70000	700	4	0	µg/L
Hexachlorobutadiene	0	0	0	0	109	1.09	4	0	µg/L
Isopropylbenzene	0	0	0	0			4	0	µg/L
Methylene chloride	1.475	0	5.9	2.95	500	5	4	1	µg/L
n-Butylbenzene	0	0	0	0			4	0	µg/L
n-Propylbenzene	0	0	0	0			4	0	µg/L
Naphthalene	1.275	0	5.1	2.55	146000	1460	4	1	µg/L
sec-Butylbenzene	0	0	0	0			4	0	µg/L

Table 4.5
Groundwater Summary Statistics

ANALYTE	MEAN	MIN	MAX	SD	TIER I	TIER II	NO.	NO. DETECTS	Units
Styrene	0	0	0	0	10000	100	4	0	µg/L
tert-Butylbenzene	0	0	0	0			4	0	µg/L
Tetrachloroethylene	2.03	0	7.6	3.72	500	5	4	3	µg/L
Toluene	0.18	0	0.4	0.21	100000	1000	4	2	µg/L
trans-1,2-Dichloroethylene	0	0	0	0			4	0	µg/L
trans-1,3-Dichloropropylene	0	0	0	0	47.3	0.473	4	0	µg/L
Trichloroethylene	0.3	0	1.2	0.6	500	5	4	1	µg/L
Trichlorofluoromethane	0	0	0	0			4	0	µg/L
Trichlorotrifluoroethane	0	0	0	0			4	0	µg/L
Vinyl chloride	0	0	0	0	200	2	4	0	µg/L
Xylenes (total)	0	0	0	0	1000000	10000	4	0	µg/L

Shaded result exceeds Tier II Action level for Groundwater

Table 4.6
Analytes In Groundwater Exceeding Tier II Action Levels

Analyte	Number Exceeding Tier II Action Level				
	Project Total	3 (Rm 182 East Side)	6 (771/776 Tunnel)	14 (Rm 146C)	16 (East Hallway)
Radionuclides					
AM241	2		1		1
PU239/240	2		1		1
U233/234	4	1	1	1	1
U238	4	1	1	1	1
Metals					
Aluminum	2			1	1
Arsenic	1				1
Barium	1				1
Beryllium	1				1
Cadmium	1				1
Chloroform	1		1		
Chromium	1				1
Copper	1				1
Lead	4	1	1	1	1
Lithium	1				1
Manganese	1				1
Nickel	1				1
Nitrate	1			1	
Selenium	1			1	
Vanadium	1				1
VOCs					
1,1,2,2-Tetrachloroethane	1		1		
Carbon tetrachloride	2		1		1
Methylene chloride	1		1		
Tetrachloroethylene	1		1		

APPENDIX 3

DATA QUALITY ASSESSMENT

DATA QUALITY ASSESSMENT

The Data Quality Objectives (DQO) of this project, as defined in the IASAP (DOE 2001b), were achieved based on the Data Quality Assessment (DQA) provided herein, which details project discussion and verification and validation (V&V) of project data. The DQOs were designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate. Data requirements to support this project were developed and implemented using criteria established in *Guidance for the Data Quality Objective Process*, QA/G-4 (EPA 2000).

Data used in making management decisions for remediation and waste management must be of adequate quality to support the decisions. Adequate data quality for decision making is required by the Kaiser-Hill (K-H) Team Quality Assurance Program (K-H, 1997, §7.1.4 and 7.2.2), as well as by the customer (DOE RFFO; Order O 414.1, Quality Assurance, §4.b.[2][b]). Regulators and the public also expect decisions and data that are technically and legally defensible. Verification and validation of the data ensure that data used in decommissioning and waste management decisions are usable and defensible.

V&V of the data are the primary components that define adequacy of the data. The final data are compared with original DQOs of the project, and evaluated with respect to project decisions, uncertainty within the decisions, quality criteria associated with the data, (particularly precision, accuracy, representativeness, completeness, comparability, and sensitivity). Data sets subject to V&V consist of all analytical and radiochemical results presented in the report.

Chemical and radiological media sample results were validated consistent with the following RFETS-specific documents and industry guidelines:

- K-H V&V Guidelines:

  - ✓ *General Guidelines for Data Verification and Validation*, DA-GR01-v1, December 3, 1997
  - ✓ *V&V Guidelines for Isotopic Determinations by Alpha Spectrometry*, DA-RC01-v1, 2/13/98
  - ✓ *V&V Guidelines for Volatile Organics,* DA-SS01-v1, 12/3/97
  - ✓ *V&V Guidelines for Semivolatile Organics,* DA-SS02-v1, 12/3/97

- EPA 540/R-94/013, USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.
- EPA 540/R-94/012, USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.
- Lockheed-Martin, 1997. Evaluation of Radiochemical Data Usability, ES/ER/MS-5.

This report will be submitted to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Administrative Record for permanent storage. Quality records are maintained in the Project File, under management of the project. The project is in progress and includes hardcopy and computerized records. Computerized quality records are maintained on the preliminary Remedial Action Decision Management System (RADMS) server within the following path/subdirectory: RISS\DELIVERABLES\Industrial Area\UBC 771.

DQO DECISIONS

The fundamental DQO decision for this preliminary UBC characterization consists of determining whether contamination exists (or not) beneath the 771 foundation footing. This decision is based on

the preliminary number and location of samples for adequate representativeness, and whether any given contaminant concentration exceeds its respective RFCA action level. Implementation of the DQO

decision logic relative to actions taken due to contamination, will be completed in the second phase of Building 771 UBC characterization.

Raw data and calculations relative to DQO decision rules are within the (Microsoft®) ACCESS database "UBC_771." The DQA was performed in the database "UBC_771-QA-SL." Radiological action levels are derived from industrial use exposure scenarios, whereas all other action levels are based on "open space" exposure scenarios. Use of these numbers represents the most conservative comparison of values (i.e., presenting the most likely scenario for sample results to exceed associated RFCA action levels).

Based on the results presented in this report, arsenic is the only existing contaminant in soil (below Tier I but above Tier II); nitrate and a variety of radionuclides, metals, and VOCs exceed Tier II action levels, but are also below Tier I in groundwater. The locations and depths of contaminants do not suggest either a definitive point source of contamination or a potential source's location. Rationale for this preliminary conclusion, given the limited samples collected, are as follows:

- arsenic exceedances in soil are not consistent in depth profile (i.e., between the two two-foot intervals taken);
- those exceedances (of Tier II) found in groundwater are from locations where surrounding soils are below action levels; and,
- there is no apparent correlation between groundwater contaminant location, type, or magnitude with any soil contaminant location, type, or magnitude.

Verification and Validation of Results

Verification ensures that data produced and used by the project are documented and traceable per quality requirements. Validation consists of a technical review of the data that directly support project decisions such that any limitations of the data relative to project goals are delineated and qualified. The V&V process was graded relative to the original DQOs of the project and specific criteria, as they pertain to the Precision, Accuracy, Representativeness, Completeness, Comparability and Sensitivity (PARCCS) parameters described below.

- Chain-of-Custody;
- Preservation and Hold-Times;
- Instrument Calibrations;
- Preparation Blanks;
- Interference Check Samples (metals);
- Matrix Spikes/Matrix Spike Duplicates (MS/MSD);
- Lab Control Samples (LCS);
- Field Duplicate Measurements;
- Chemical Yield (radiochemistry);
- Required Quantitation Limits/Minimum Detectable Activities (MDA) (sensitivity of chemical and radiochemical measurements, respectively); and,
- Sample Analysis and Preparation Methods.

PARCCS parameters are indicators of data quality. The following sections discuss these parameters relative to environmental decisions resulting from the project.

NOTE: The V&V for electronic records is currently in progress; a comparison of hardcopy V&V reports with the Electronic Data Deliverable (EDD) indicates validation fields within the EDD that are not yet fully populated. Based on the V&V performed on the project's data, under the sitewide program, there are no qualifications to the data that affect project decisions (i.e., that arsenic is the only contaminant of concern).

Precision

Radiochemistry (Alpha Spectroscopy)

Two (2) field duplicates – an adequate frequency at >5% of the real samples taken – were assessed to determine overall precision repeatability of the sampling process as well as lab analyses. Relative percent difference (RPD) values were calculated for each isotope to evaluate repeatability of the sampling process. Field duplicates were also blind to the laboratory to prevent any potential analytical bias. The duplicate results indicate RPD values less than 25% for all detected values; these values are acceptable, because relative differences within the sampling process would not cause exceedance of RFCA ALs given the current values.

The frequency of laboratory quality control (QC) samples (matrix duplicates, [MD]) for checking precision was adequate, at greater than a 1:10 ratio of lab duplicate samples to real samples for batch control, though these QC samples were only performed for selected isotopes and not the entire suite. Results from laboratory duplicates (replicates) indicate poor precision in repeatability based on duplicate error ratio values exceeding 1.5 for several samples and several isotopes; however, based on the field duplicates collected, as well as the low activity results used in the Duplicate Error Ratio (DER) equation, failure of the DER does not suggest potential exceedance of RFCA ALs, and thus does not affect project decisions.

Chemical Results

As stated above, two (2) field duplicates were acquired, an adequate frequency, and RPD values were calculated for each analyte. All RPD values were ≤13%, with 2 exceptions (manganese and barium), which is satisfactory for lab precision within a soil matrix, and for repeatability within the field sampling process. Lack of precision for the stated metals did not affect decisions, as this amount of sampling error would not cause exceedance of RFCA ALs.

Accuracy (and Bias)

Radiochemistry (Alpha Spectroscopy)

The frequency of laboratory QC samples was adequate, at greater than a 1:10 ratio of LCS to real samples for batch control. Blank samples were also analyzed at a satisfactory frequency for batch control (>1:10). Blanks yielded no concentrations significant enough to cause a high bias in the corresponding real samples; stated differently, there are no false positive results due to blank contamination.

Accuracy of radiochemistry results was generally within 20% of full scale measurement, and about ±1 picocuries per gram (pCi/g) for all actinides of interest at or near contractually required detection limits (i.e., 0.3 pCi/g or picocuries per liter [pCi/l] for americium-241, plutonium-239/240; 1 pCi/g or pCi/l for the uranium species). Sample-specific accuracies are reported on the laboratory reports as either total error (e.g., total propagated uncertainty [TPU]), or counting error. Accuracy of radiochemistry results was controlled through periodic laboratory calibrations, use of LCS, and measurement of chemical yields.

Recoveries of LCS were within ±20% of the spike amount, consistent with contractually-required and industry standards. Other quality controls, such as sample-specific yield percentages, are maintained in the original laboratory data packages managed by K-H Analytical Services Division in Building 881.

Chemical Results

The frequency of laboratory QC samples (LCS, MS, and preparation blanks [PB]) for controlling accuracy was adequate, at greater than a 1:10 ratio of LCS samples to real samples for batch control, though these QC samples were only performed for selected analytes and not the entire suite.

Some volatile compounds were detected in the trip blank, but not at concentrations to cause positive bias in the real samples (i.e., positive bias due to cross-contamination of samples in the containerization and/or shipping process).

Methylene chloride results in real samples were biased high due to blank contamination. Use of the 10 times (10x) rule as provided by the U.S. Environmental Protection Agency (EPA) (EPA 1994) indicates that detections of the contaminant in real samples are not significant, but are caused by laboratory cross-contamination. All real results of methylene chloride are less than 10 times the lowest concentrations found in the blanks (0.57 parts per billion). Therefore, the positive detections of methylene chloride in real samples are qualified as "nondetects" and do not constitute contamination.

Table 1 lists the only results that have been rejected to this time; rejection was based on accuracy criteria.

Table 1 Rejected Analytes

Analytical Method	Analyte	Sample Number	Reason for Rejection
SW 9056	Sulfide (soil)	01N0189-001.006 01N0189-002.006 01N0190-001.006 01N0190-002.006 01N0192-001.006 01N0190-002.006	MS %R <50%
	Nitrite (water) Ortho-phosphate	01N0143-001.007	
SW6020	Antimony (water)	01N0194-002.006	MS %R <30%

Representativeness

Sample locations and media types acquired for the project are representative of media beneath the Building 771 concrete foundation based on the following criteria:

- Familiarity with facilities - multiple walk-downs and collaborations by management and technical staff;
- Review of documented historical processes within the building and interviews with building personnel;
- Implementation of industry-standard Chain-of-Custody protocols;

- Compliance with sample preservation and hold times;
- Documented and Site-approved methods, particularly radiological safety practices for scans/surveys and the following documents for alpha spectroscopy;
- Use of an approved Sampling and Analysis Plan (*Addendum 1 to the Industrial Area Sampling and Analysis Plan, Preliminary Building 771 Under Building Contamination,* March 15, 2001); and
- Sample types, locations, and depths that target the most likely media and locations of contamination; these locations/depths are documented in Section 3.1.

All sample types and quantities are detailed in the next section.

Completeness

Sampling completeness is addressed in Table 2. Deficits in planned vs. actual samples are noted in the "Comments" column.

Table 2. 771 UBC Sample Completeness Summary

# Samples Planned (incl. Media; Real & QC Samples)	# Samples Taken (Real & QC Samples)[1]	Project Decisions (Conclusions) & Uncertainty	Comments
VOCs			
32 Real 2 Field Dups 2 EB 1 TB	34 soil (32 real, 2 field dups) 17 water 25 LCS 5 MS 5 MD 25 MB 1 TB 1 EB	Contamination in groundwater sample(s)	
SVOCs			
32 Real 2 Field Dups 2 EB 1 TB	34 soil (32 real, 2 field dups) 1 water 12 LCS 11 MS 11 MD 12 MB 1 TB 1 EB	No contamination	
PCBs			
32 Real 2 Field Dups 2 EB 1 TB	34 soil (32 real, 2 field dups) 2 water 13 LCS 11 MS 11 MD 13 MB 1 TB 1 EB	No contamination	
Metals			
32 Real 2 Field Dups 2 EB 1 TB	34 soil 32 real, 2 field dups 5 water 13 LCS 12 MS 12 MD 13 MB 1 TB 1 EB	No contamination	

# Samples Planned (incl. Media; Real & QC Samples)	# Samples Taken (Real & QC Samples)[1]	Project Decisions (Conclusions) & Uncertainty	Comments
	TPH		
32 Real 2 Field Dups 2 EB 1 TB	32 soil 30 reals, 2 field dups 10 water ≥ 9 LCS ≥ 4 MS ≥4 MD ≥9 MB 1 TB 1 EB	No contamination	
	Cyanide		
32 Real 2 Field Dups 2 EB 1 TB	34 soil 32 reals, 2 field dups 1 water 11 LCS 11 MS 11 MD 11 MB 1 TB 1 EB	No contamination	
	Anions		
32 Real 2 Field Dups 2 EB 1 TB	22 soil 20 reals, 2 field dups 4 water LCS MS MB 1 TB 1 EB	No contamination	10 real samples outstanding No impact on decisions because no comparison with RFCA is required.
	RADIOCHEMICAL (Alpha Spec)		
32 Real 2 Field Dups 2 EB 1 TB	30 soil 28 real, 2 field dups 5 water 10 LCS 10 LCSD 10 MB (PB) 1 TB 1 EB	No contamination	2 real samples outstanding

[1]Acronyms
Dups = Duplicate Sample
LCS = Lab Control Sample
LD = Lab Duplicate
MB = Method Blank
MC – Matrix Spike Duplicate
MS = Matrix Spike
PB = Preparation Blank
TB = Trip Blank
EB = Equipment Blank

36

Comparability

All results presented are comparable with CERCLA data on a DOE site- and complex-wide basis. This comparability is based on:

- Use of standardized engineering units in the reporting of measurement results;
- Consistent sensitivities of measurements (≤CRDL or MDA);
- Use of Site-approved procedures (Contractual Statements of Work for lab analyses, §1.1);
- Systematic quality controls; and
- Thorough documentation of the planning, sampling/analysis process, and data reduction into formats designed for making decisions posed from the project's original data quality objectives.

Sensitivity

Adequate sensitivities, expressed as detection limits (DL) in units of micrograms per kilogram (µg/kg) for semivolatile organic compounds (SVOCs) and VOCs, milligrams per kilogram (mg/kg) for metals, and pCi/g for radionuclides (also expressed as MDA), were attained for most analytes, with a listing of the exceptions given in Table 3 below. For those analytes exceeding Tier I ALs, all results were nondetects, and therefore are not considered contamination; the detection limits in question are consistent with industry-standard implementation of SW-846 methodology. The same comments are applicable to those analytes exceeding Tier II ALs. Beryllium detection limits were well below naturally occurring background values, and thus the detection limit does not affect decisions. Ideally, detection limits are at least one-half the action level. For those exceedances listed below, the RFCA Tier II ALs relative to the method-specific sensitivities are currently under review.

Table 3 Analytes with Detection Limits that Exceed RFCA Action Levels

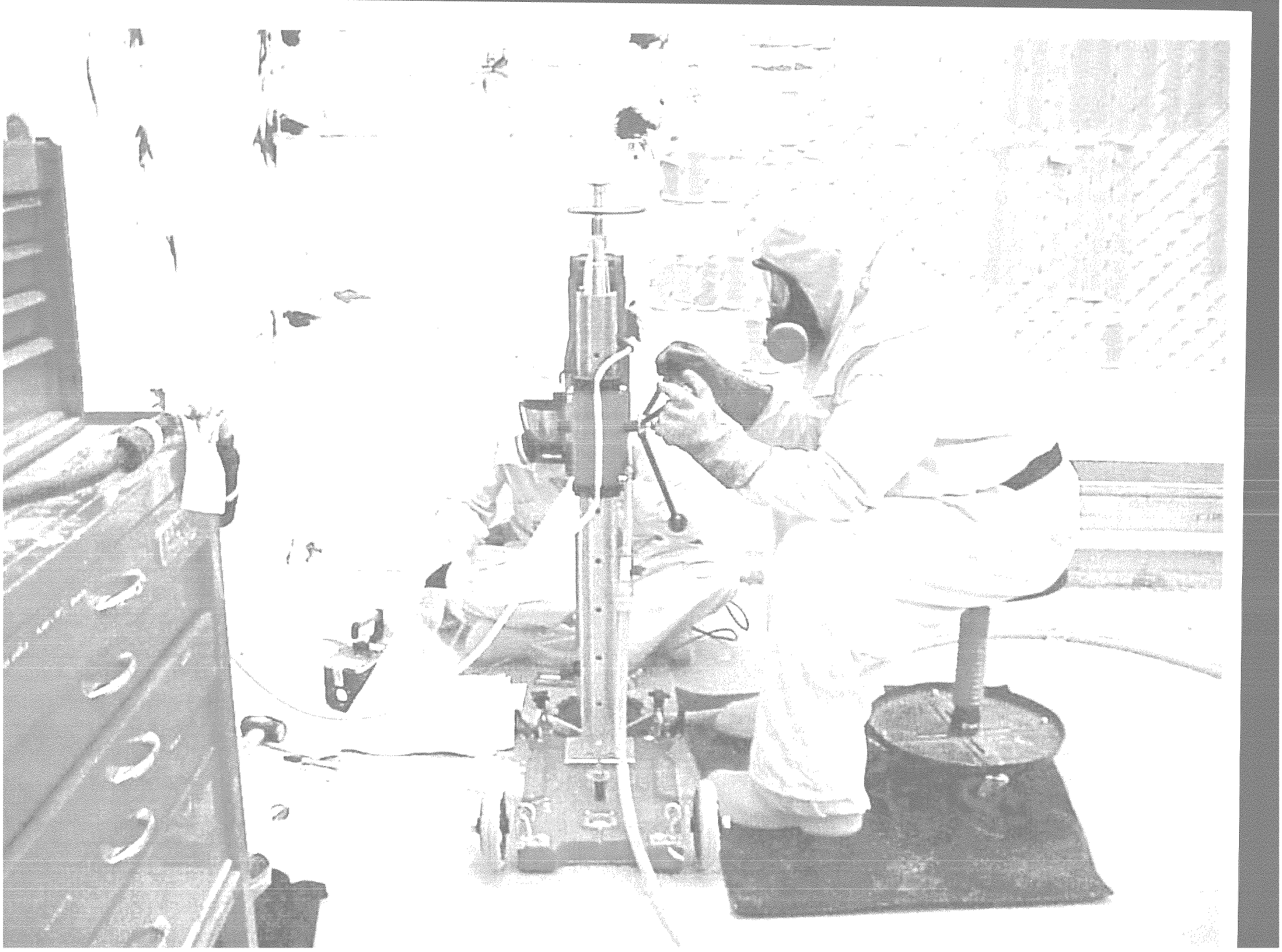
ANALYTE DL > RFCA Tier I	ANALYTE DL > RFCA Tier II	ANALYTE DL > RFCA Tier II, Cont.
2,4-Dinitrophenol	1,1,2,2-Tetrachloroethane	Benzo(a)anthracene
2,4-Dinitrotoluene	1,1,2-Trichloroethane	Beryllium
2,6-Dinitrotoluene	1,2-Dichloroethane	bis(2-Chloroethyl) ether
3,3'-Dichlorobenzidine	1,2-Dichloropropane	cis-1,3-Dichloropropylene
Bis(2-Chloroethyl) ether	1,4-Dichlorobenzene	Dibenzo(a,h)anthracene
N-Nitrosodipropylamine	2,4,6-Trichlorophenol	Diphenylamine
Pentachlorophenol	2,4-Dichlorophenol	Hexachloroethane
	2,4-Dinitrophenol	Isophorone
	2,4-Dinitrotoluene	Methylene chloride
	2,6-Dinitrotoluene	N-Nitrosodipropylamine
	3,3'-Dichlorobenzidine	Nitrobenzene
	4-Chloroaniline	Pentachlorophenol
	Arsenic	trans-1,3-Dichloropropylene
	Benzene	Vinyl chloride

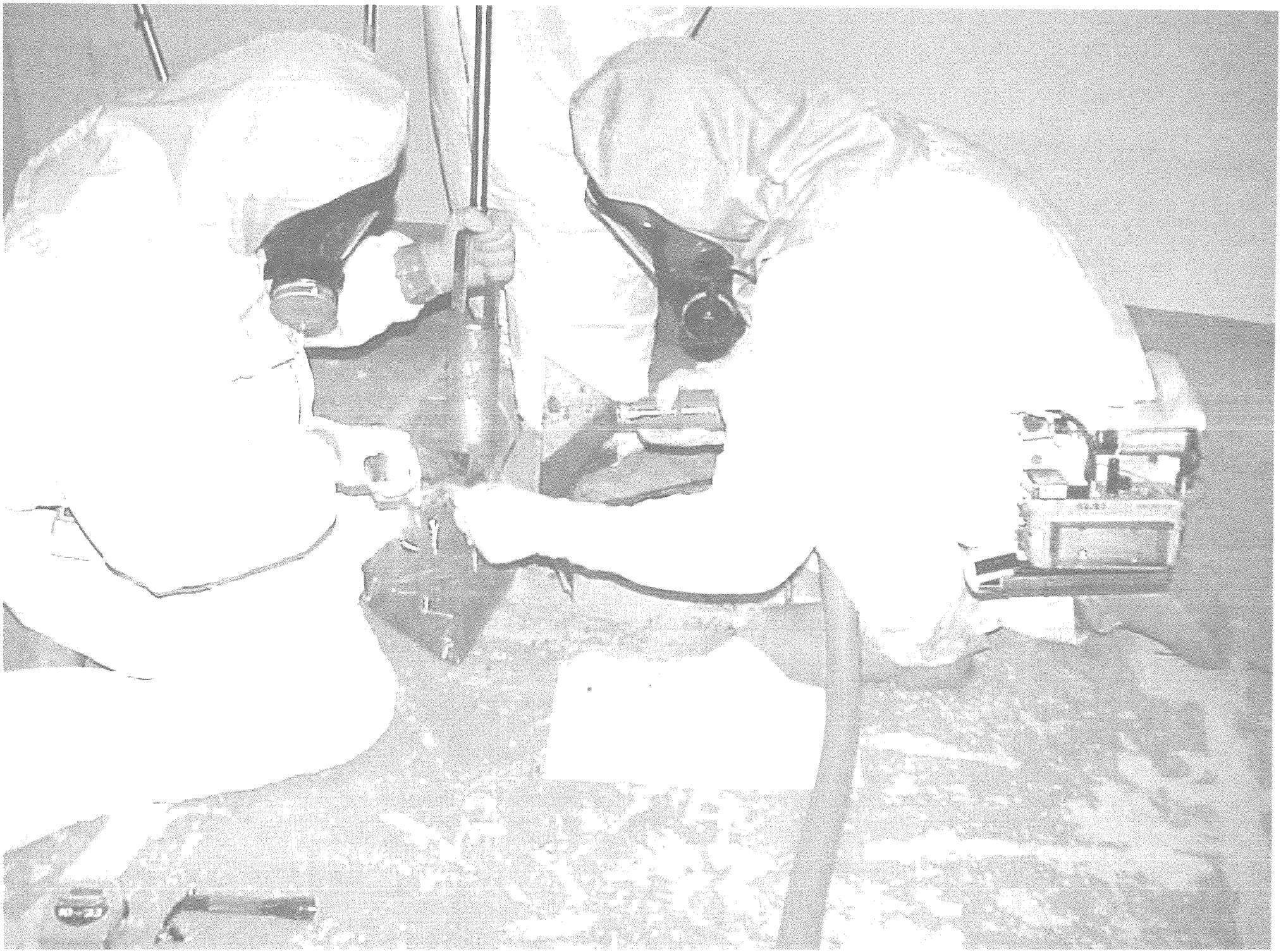
DQA SUMMARY

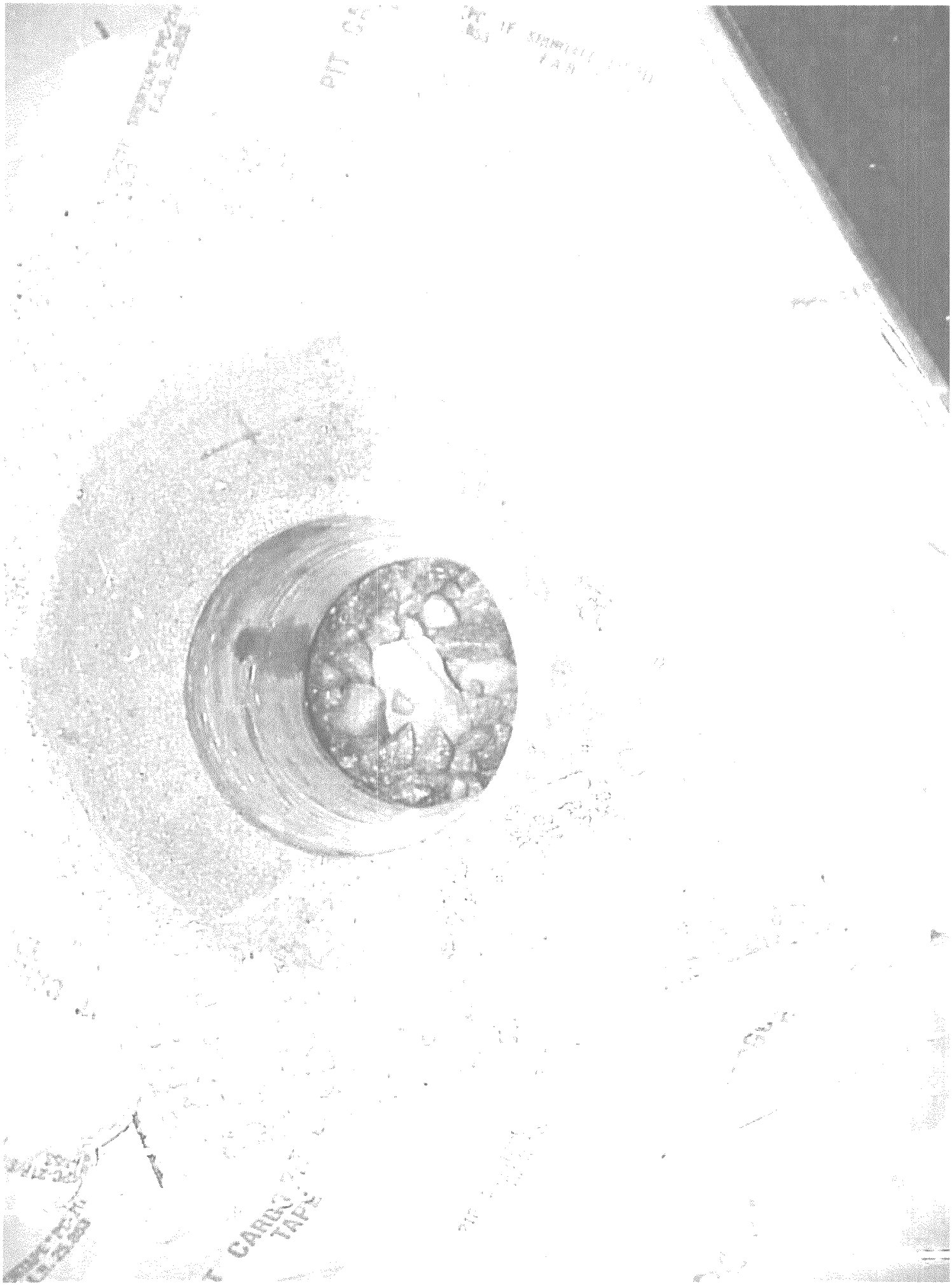
In summary, the data presented in this report have been verified and validated to the extent described, for the purpose of corroborating decisions to acceptable levels of confidence as stated in the original DQOs.

APPENDIX 4

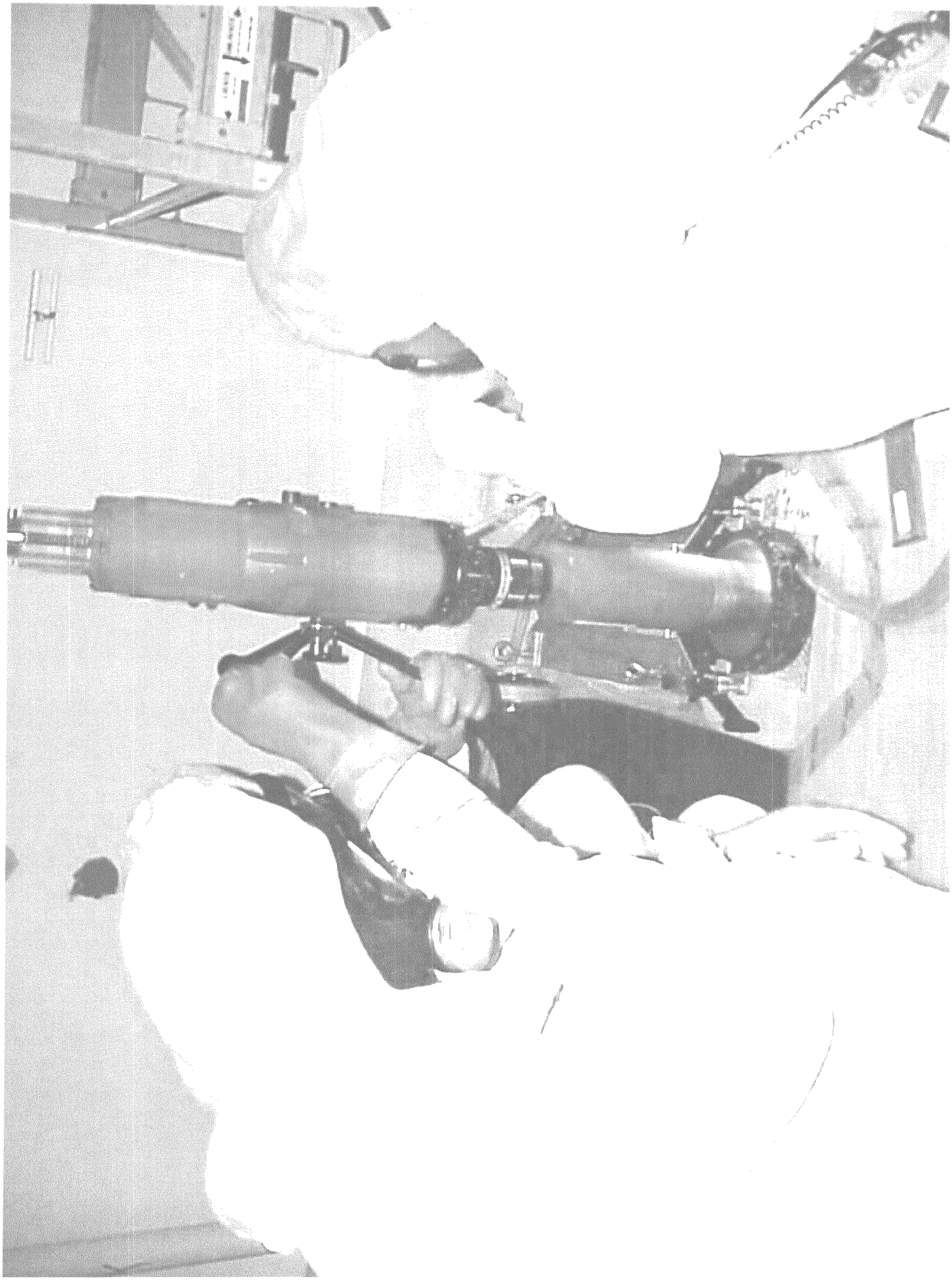
PHOTOGRAPHS







void



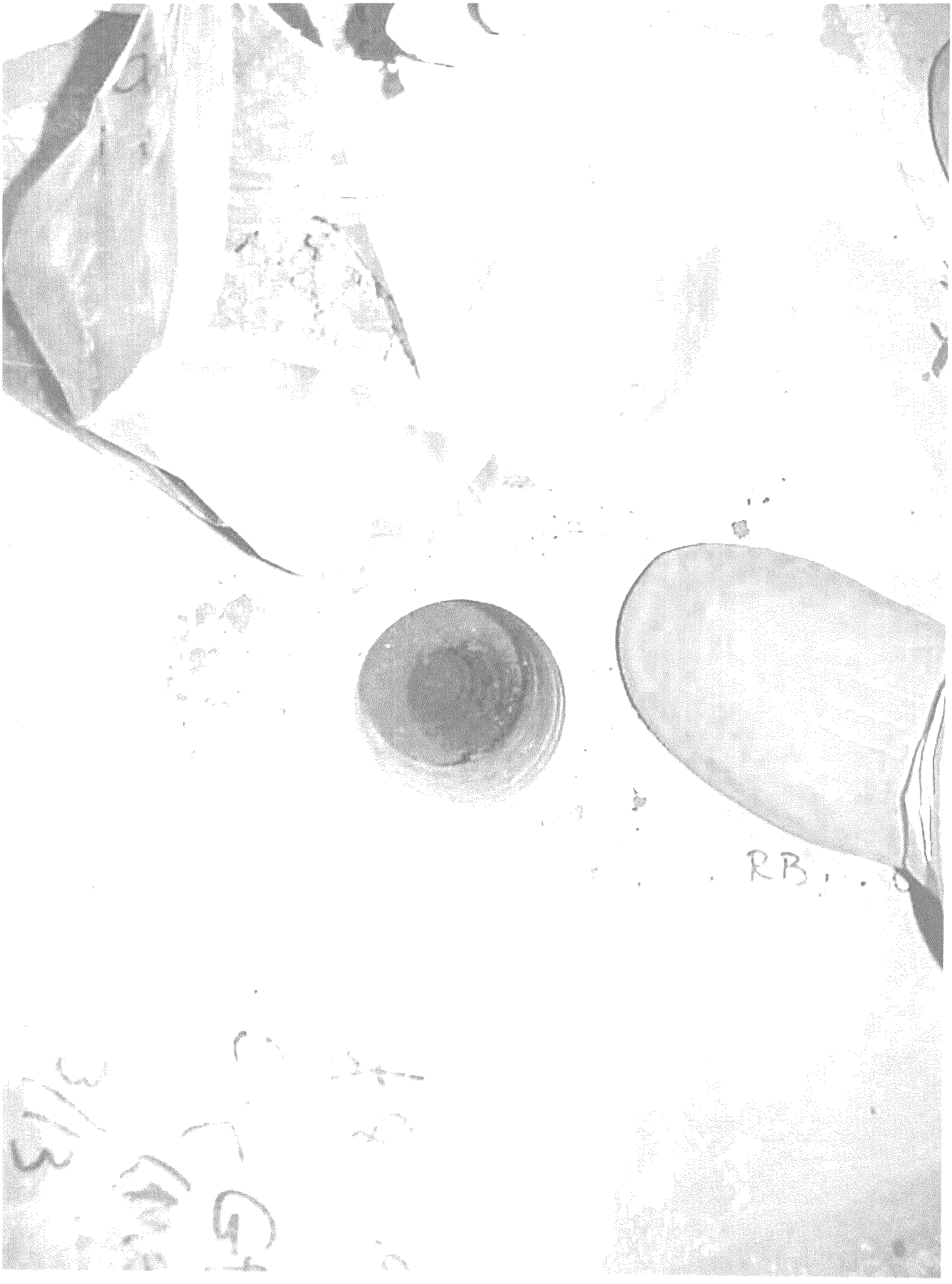
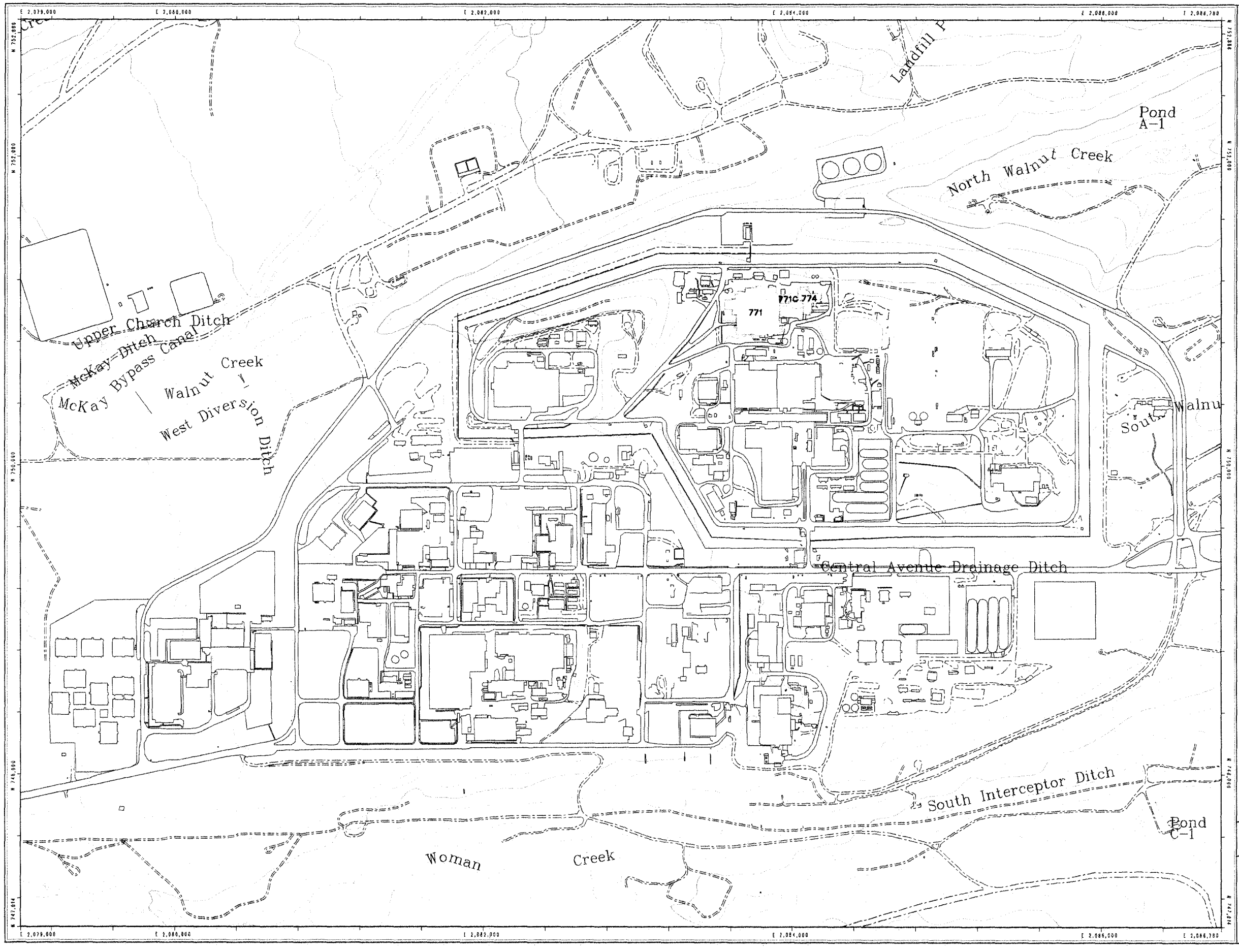


Figure 1

Location of Building 771/774 Cluster



EXPLANATION

Buildings 771 & 774

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Topographic Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95.

Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at – 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

Subject Matter Expert:
Tracey Spence (303) 966-4322
Building # 115 Room # 72

Scale = 1 : 7580
1 inch represents approximately 632 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER+HILL COMPANY

MAP ID: 01-0092/b771-774.aml

August 23, 2001

NT_Svr w:/projects/fy2001/01-0092/b771-774.aml